

## Module 6 - Steady State Circuits

ME3023 - Measurements in Mechanical Systems

Mechanical Engineering

Tennessee Technological University

### Topic 2 - Fundamental Laws

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- Ohm's Law
- Combining Resistance
- Kirchhoff's Laws
- Power Dissipation

# Ohm's Law

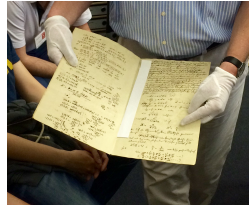
James Maxwell



George Ohm



Ohm's Notebook



Ohm did his work on resistance in the years 1825 and 1826, and published his results in 1827 as the book *Die galvanische Kette, mathematisch bearbeitet*...

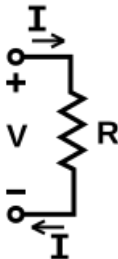
# Ohm's Law

Ohm's law states that the current through a conductor between two points is directly proportional to the voltage across the two points.

$$I = \frac{V}{R}$$

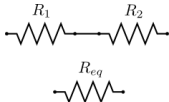
It is more commonly shown in the following form.

$$V = IR$$



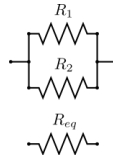
# Combining Resistance

## Resistors in Series



$$R_{eq} = R_1 + R_2$$

## Resistors in Parallel



$$R_{eq} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$$

# Kirchhoff's Laws

Both of Kirchhoff's laws can be understood as corollaries of Maxwell's equations in the low-frequency limit. They are accurate for DC circuits, and for AC circuits at frequencies where the wavelengths of electromagnetic radiation are very large compared to the circuits.

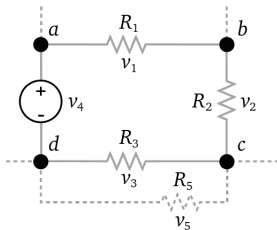
- 1 Kirchhoff's Voltage Law (KVL)
- 2 Kirchhoff's Current Law (KCL)

# Kirchhoff's Laws

## Kirchhoff's Voltage Law (KVL) -

The sum of the voltages around a loop (aka mesh) equals zero.

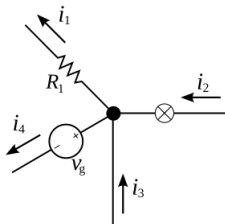
$$\sum_{k=1}^n v_k = 0$$



## Kirchhoff's Current Law (KCL) -

The sum of the current flowing in and out of node (aka junction) equals zero.

$$\sum_{k=1}^n i_k = 0$$



# Power Dissipation

Energy is transformed in to heat in passive circuit components. For a resistor the power dissipation can be found with following relations.

$$P = IV$$

$$V = IR$$



# Power Dissipation

Power is the rate of energy dissipated, aka the amount of energy lost per unit of time. How do we compute total energy for the power?

$$E = \int_{t1}^{t2} P dt$$